CLAIMS:

1. Disc drive apparatus (1) comprising:

- scanning means (30) for scanning a record track of an optical disc (2) and for generating a read signal (S_R);

- actuator means (50) for controlling the positioning of at least one read/write element (34) of said scanning means (30) with respect to the disc (2);

- a control circuit (90) for receiving said read signal (S_R) and generating at least one actuator control signal (S_{CR}, S_{CF}, S_{CT}; SAD) on the basis of at least one signal component of said read signal (S_R);

wherein the control circuit (90) comprises:

- means (111, 112) for calculating at least one error signal (RES; e(k)) on the basis of the said read signal (S_R);

- error signal processing means (120) for receiving said at least one error signal (RES; e(k)) and for outputting derived signals ($\sigma 1$, $\sigma 2$, $\sigma 3$);

- shock detector means (130) for generating a shock indication signal (SIS);

- actuator control signal generator means (190) having at least one variable control parameter, for receiving one ($\sigma 2$) of said derived signals from said error signal processing means (120) and for processing this derived signal for generating an actuator signal (RAD; u(k));

- the actuator control signal generator means (190) being coupled to receive the shock indication signal (SIS) from the shock detector means (130), the actuator control signal generator means (190) being designed to set a first value for said variable control parameter during normal operation, and to set a second value for said variable control parameter when said shock indication signal (SIS) indicates the occurrence of a shock;

wherein said actuator control signal generator means (190) is designed to perform sliding mode control (SMC).

2. Disc drive apparatus according to claim 1, wherein said actuator control signal generator means (190) is designed to calculate its output signal (u(k)) according to the formula

$$u(k) = k \cdot [\varepsilon sat(\frac{g_{res}\bar{x}(k) + g_v\bar{v}(k)}{\Phi}) + kk_1\bar{x}(k) + kk_2\bar{v}(k)]$$

wherein kk1 and kk2 and k are coefficients determined by the actuator dynamic characteristics and the SMC controller gains;

wherein $S(k) = g_{res} \cdot x(k) + g_v \cdot v(k) = 0$ describes a time-invariant surface in the state space, "g_{res}" and "g_v" being constants which are selected such that S(k)=0 defines a stable sliding surface;

wherein $sat(g_{res} \cdot x(k) + g_v \cdot v(k)/\Phi)$ defines a saturation function;

and wherein ϵ is a gain factor being the said variable control parameter of the SMC actuator control signal generator means (190);

and wherein $\bar{x}(k)$ and $\bar{v}(k)$ are signals representing values for the current actuator position and speed.

3. Disc drive apparatus according to claim 2, wherein said error signal processing means (120) is designed to calculate estimated values $\bar{x}(k)$ and $\bar{v}(k)$ for the current actuator position and speed;

wherein the actuator control signal generator means (190) is coupled to receive said estimated current actuator position and speed signals ($\bar{x}(k)$ and $\bar{v}(k)$) from said error signal processing means (120);

and wherein said actuator control signal generator means (190) is designed to calculate its output signal (u(k)) on the basis of the estimated values received from said error signal processing means (120).

4. Disc drive apparatus according to claim 1, wherein said control circuit (90) further comprises:

- disturbance estimator means (140) for receiving said actuator signal (RAD; u(k)) from said actuator control signal generator means (190) and for receiving a third derived signal ($\sigma 3$) from said error signal processing means (120), the disturbance estimator means (140) being designed to generate an estimated disturbance signal ($\bar{d}(k)$) on the basis of said actuator signal (RAD; u(k)) and said third derived signal ($\sigma 3$);

wherein said actuator control signal generator means (190) is coupled to receive said estimated disturbance signal ($\bar{d}(k)$) from the disturbance estimator means (140), said

actuator control signal generator means (190) being designed to calculate its output signal on the basis of said estimated disturbance signal ($\bar{d}(k)$) also.

5. Disc drive apparatus according to claim 4, wherein said actuator control signal generator means (190) is designed to calculate its output signal (u(k)) according to the formula

$$u(k) = k \cdot [\varepsilon sat(\frac{g_{res}\bar{x}(k) + g_v\bar{v}(k)}{\Phi}) + kk_1\bar{x}(k) + kk_2\bar{v}(k) + \bar{d}(k)]$$

wherein kk1 and kk2 and k are coefficients determined by the actuator dynamic characteristics and the SMC controller gains;
wherein $S(k) = g_{res} \cdot x(k) + g_v \cdot v(k) = 0$ describes a time-invariant surface in the state space, "g_{res}" and "g_v" being constants which are selected such that S(k)=0 defines a stable sliding surface;
wherein $sat(g_{res} \cdot x(k) + g_v \cdot v(k)/\Phi)$ defines a saturation function;
and wherein ϵ is a gain factor being the said variable control parameter of the SMC actuator control signal generator means (190);
and wherein $\bar{x}(k)$ and $\bar{v}(k)$ are signals representing values for the current actuator position and speed.

6. Disc drive apparatus according to claim 5, wherein said error signal processing means (120) is designed to calculate estimated values $\bar{x}(k)$ and $\bar{v}(k)$ for the current actuator position and speed;
wherein the actuator control signal generator means (190) is coupled to receive said estimated current actuator position and speed signals ($\bar{x}(k)$ and $\bar{v}(k)$) from said error signal processing means (120);
and wherein said actuator control signal generator means (190) is designed to calculate its output signal (u(k)) on the basis of the estimated values received from said error signal processing means (120).

7. Disc drive apparatus according to claim 6, wherein said error signal processing means (120) comprises a state estimator (120) which is coupled to receive said actuator signal (RAD; u(k)) from said actuator control signal generator means (190);

wherein said state estimator (120) is designed to calculate a predicted position signal ($\hat{x}(k+1)$) in accordance with the formula:

$$\hat{x}(k+1) = A_d(1,1)\bar{x}(k) + A_d(1,2)\bar{v}(k) + B_d(1)u(k)$$

wherein said state estimator (120) is designed to calculate a predicted speed signal ($\hat{v}(k+1)$) in accordance with the formula:

$$\hat{v}(k+1) = A_d(2,1)\bar{x}(k) + A_d(2,2)\bar{v}(k) + B_d(2)u(k)$$

wherein $\mathbf{A}_d$ (2x2) and $\mathbf{B}_d$ (2x1) are constant matrices and vectors for the discrete model of the actuator;

and wherein $\bar{x}(k)$ and $\bar{v}(k)$ are estimated values for the current position and the current speed of the actuator, respectively;

and wherein said state estimator (120) is designed to calculate $\bar{x}(k)$ and $\bar{v}(k)$ in accordance with the formulas:

$$\bar{x}(k) = \hat{x}(k+1)/z + L_{res}(x(k) - \hat{x}(k+1)/z)$$
$$\bar{v}(k) = \hat{v}(k+1)/z + L_v(x(k) - \hat{x}(k+1)/z)$$

wherein L_{res} and L_v are the estimator gains, preferably determined by the Linear Quadratic Regulator (LQR) method.

8. Disc drive apparatus according to claim 7, wherein said shock detector means (130) are designed to generate said shock indication signal (SIS) on the basis of said predicted position signal ($\hat{x}(k+1)$).

9. Disc drive apparatus according to claim 8, wherein said shock detector means (130) comprise:

- a low pass filter (133) for receiving said predicted position signal ($\hat{x}(k+1)$); and
- a comparator (134) for receiving an output signal from said low pass filter (133) and for providing said shock indication signal (SIS).

10. Disc drive apparatus according to claim 9, wherein said low pass filter (133) has a cut-off frequency in the order of about 850 Hz.

11. Disc drive apparatus according to claim 9, wherein said comparator (134) is designed to compare the output signal from said low pass filter (133) with a predefined

threshold value which, in the case of radial control, corresponds to approximately 25% of the track pitch.

12. Disc drive apparatus according to claim 9, wherein said comparator (134) is designed to compare the output signal from said low pass filter (133) with a predefined threshold value which, in the case of radial control, corresponds to approximately 20% of the track pitch.

13. Disc drive apparatus according to claim 1, wherein said actuator signal generated by said actuator control signal generator means (190) is a digital actuator signal (RAD; u(k)), and wherein said control circuit (90) further comprises:

- D/A signal processing means (196) for receiving said digital actuator signal (RAD; u(k)) from said actuator control signal generator means (190) and for generating an analogue actuator signal (RAA; u(s));
- preferably, noise filter means (197) for receiving said analogue actuator signal (RAA; u(s)) from said D/A signal processing means (196) and for generating a filtered actuator signal (SAF);
- actuator driver means (198) for receiving said analogue actuator signal (RAA; u(s)) from said D/A signal processing means (196) or receiving said filtered actuator signal (SAF), and for generating an actuator drive signal (SAD; S_{CR}, S_{CF}, S_{CT}).